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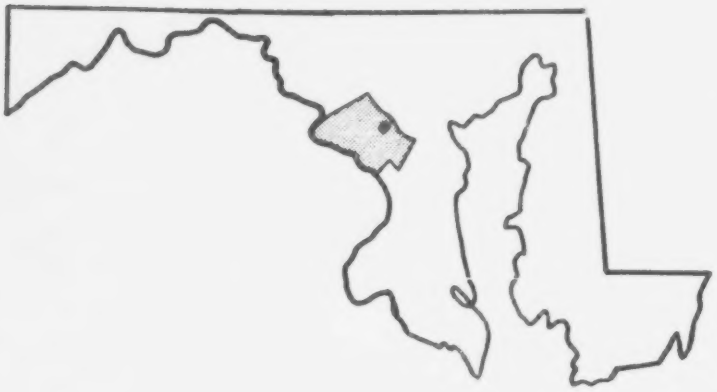
FLOOD INSURANCE STUDY

TOWN OF BROOKEVILLE, MARYLAND
MONTGOMERY COUNTY



JUNE 19, 1989

Federal Emergency Management Agency

COMMUNITY NUMBER - 240166

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance study purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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FLOOD INSURANCE STUDY
TOWN OF BROOKEVILLE, MONTGOMERY COUNTY, MARYLAND

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Town of Brookeville, Montgomery County, Maryland, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Dalton, Dalton, Little, and Newport during the preparation of the Flood Insurance Study for the unincorporated areas of Montgomery County, Maryland.

1.3 Coordination

On September 25, 1987, the Town of Brookeville was notified by the Federal Emergency Management Agency (FEMA) of the initiation of a Flood Insurance Study for the community.

On July 14, 1988, a final Consultation and Coordination Officer's (CCO) meeting was held with representatives of FEMA and the town to review the results of the study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Brookeville, Montgomery County, Maryland. The area of study is shown on the Vicinity Map (Figure 1).

The following streams were studied by detailed methods: Reddy Branch, from approximately 550 feet downstream of the downstream corporate limits upstream to the confluence of Tributary No. 209; and Tributary No. 209, from its confluence with Reddy Branch to the upstream corporate limits. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

2.2 Community Description

The Town of Brookeville is located in eastern Montgomery County in central Maryland. It is surrounded by the unincorporated areas of Montgomery County.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

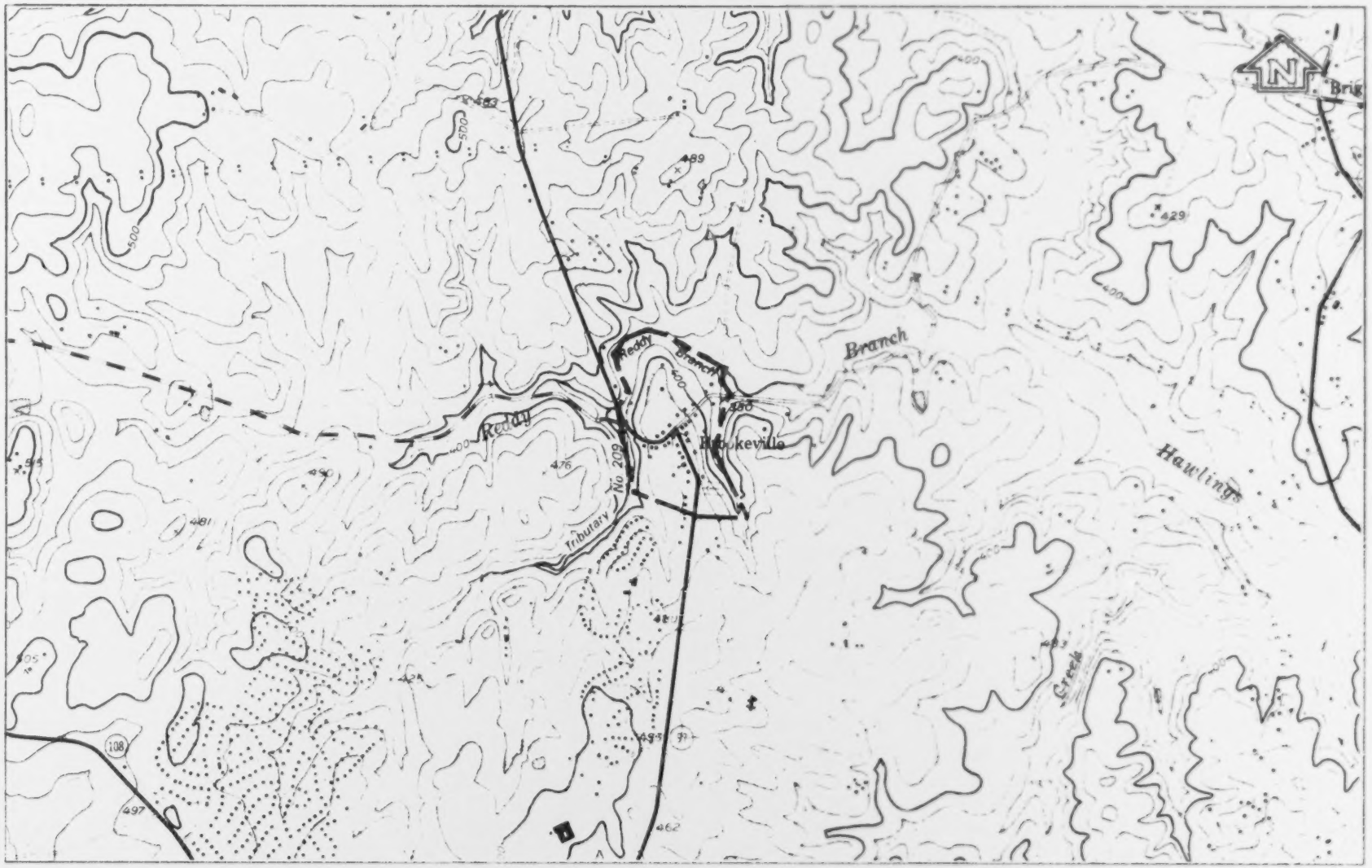


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF BROOKEVILLE, MD

(MONTGOMERY CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

VICINITY MAP

The hydrologic analyses for the streams studied by detailed methods were obtained from the Flood Insurance Study for the unincorporated areas of Montgomery County (Reference 1). In that study, the hydrologic analyses were determined using the map of isopleths of generalized skew coefficients of annual peak discharges prepared by the U. S. Geological Survey (USGS) (Reference 2). In this frequency analysis, the plotted positions of existing data were based on the Gringorten formula, since this method produced a better fit when used in log-Pearson Type III distribution analysis (References 3 and 4). In accordance with the directive issued by FEMA, no expected probability adjustment was made in the frequency analysis.

In order that the results of the frequency analyses of the gages could be projected to different locations in the study area, curves of the drainage area-peak discharge relationships were prepared using records of those gages judged to have sufficiently similar drainage basin characteristics. Mean values of peak discharges were calculated using contemporary periods of records and plotted against drainage areas on log-log graph paper from which the equations of the best-fit curves were derived. A relationship was then developed between drainage area and discharge in order to allow projection of discharges for selected frequency floods to different locations of the gaged watersheds and to ungaged watersheds having similar basin characteristics. The projection equation took the following general form:

$$Qs/Qg = (As/Ag)^n \qquad As\ (p \log As)/Ag\ (p \log Ag)$$

where Qg and Ag are the discharge and drainage area at the gage, Qs and As the discharge and drainage area at the site in question, "p" is a coefficient, and "n" is an exponent.

Based upon these relationships, the various peak discharges on ungaged streams with similar basin characteristics, and at other locations on gaged streams, were projected from the corresponding results of frequency analysis of the gages. In estimating peak discharge-frequency relationships, effects of existing flood control reservoirs were separately evaluated.

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
REDDY BRANCH					
Immediately upstream of confluence of Tributary No. 209	2.22	772	1,400	1,751	2,814

TABLE 1 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
REDDY BRANCH - continued					
Immediately downstream of confluence of Tributary No. 209	3.49	1,071	1,943	2,429	3,904
TRIBUTARY NO. 209					
Immediately upstream of confluence with Reddy Branch	1.27	499	905	1,132	1,819

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

The hydraulic analyses for the streams studied by detailed methods were obtained from the Flood Insurance Study for the unincorporated areas of Montgomery County (Reference 1).

Cross sections for the backwater analyses of the streams including the overbank portions, details of structures such as bridges and culverts, and the profiles of the top of the roadway were obtained through field surveys, photogrammetric modeling, and field reconnaissance.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (References 5, 6, 7, and 8). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations were established using a methodology developed by Dalton, Dalton, Little, and Newport (Reference 9). This procedure was used to overcome the lack of data necessary to utilize the options provided by the HEC-2 program and to obtain an accurate elevation without beginning the calculations at an excessive length downstream of the community boundary.

Initial estimates of channel roughness values (Manning's "n") used in the hydraulic computations for the streams studied by detailed methods were assigned from information collected in the field regarding vegetation and surface soils and irregularities. The initial estimates of roughness coefficients as well as other parameters, such as bridge loss coefficients, and weir coefficients were slightly modified to make the computed water-surface profile for the projected flood-of-record discharges match the high-water marks at all available locations. For Reddy Branch and Tributary No. 209, the channel "n" values ranged from 0.015 to 0.12 and the overbank "n" values ranged from 0.025 to 0.220.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 3).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For the streams studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 10 feet (Reference 10).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 2). On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zone AE), and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries

are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 2). The computed floodways are shown on the Flood Insurance Rate Map (Exhibit 2). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 2 for certain downstream cross sections of Tributary No. 209 are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH[3] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Reddy Branch								
A	5,790[1]	158	552	5.21	352.7	352.7	352.7	0.0
B	7,000[1]	39	186	13.06	365.6	365.6	365.6	0.0
Tributary No. 209								
A	100[2]	380	1,559	0.73	382.0	381.8[4]	381.8	0.0
B	220[2]	258	697	1.62	382.0	381.8[4]	381.8	0.0

[1]Feet above confluence with Hawlings River
[2]Feet above confluence with Reddy Branch
[3]This width extends beyond corporate limits
[4]Elevations computed without consideration of backwater effects from Reddy Branch

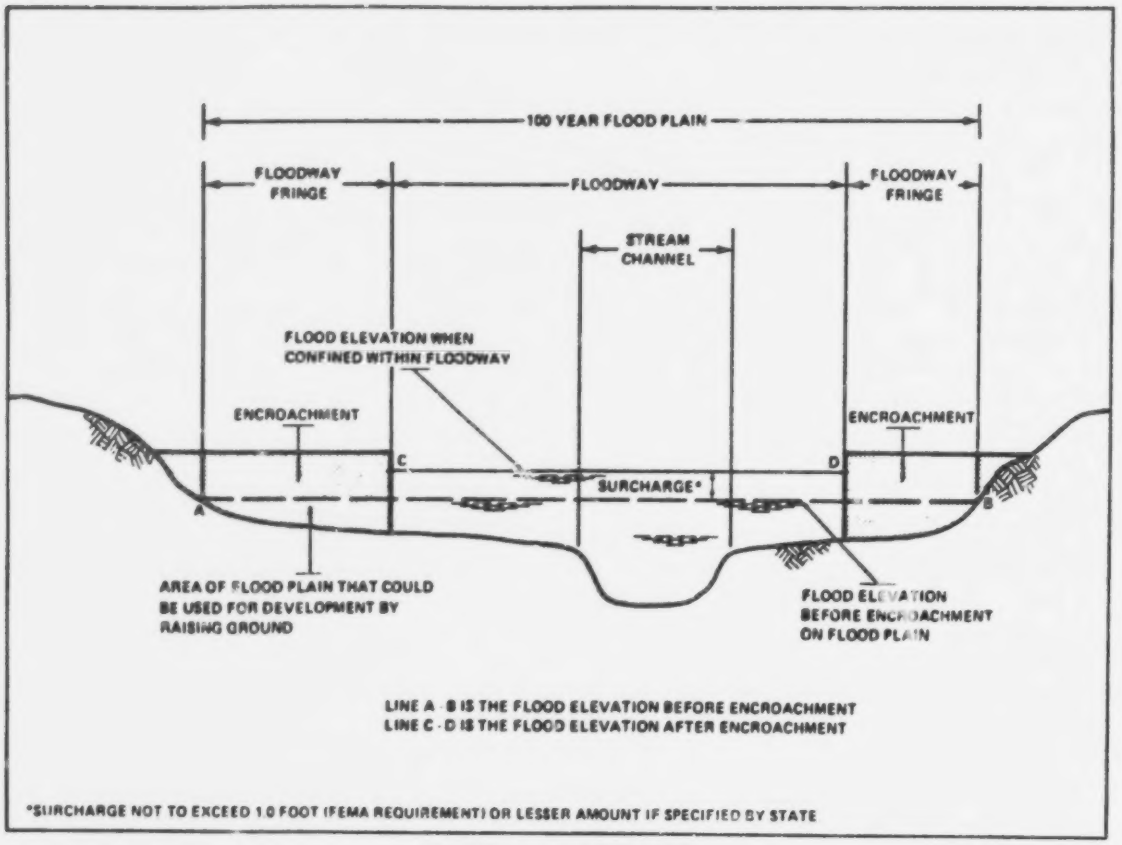
TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF BROOKEVILLE, MD
(MONTGOMERY CO.)

FLOODWAY DATA

REDDY BRANCH - TRIBUTARY NO. 209


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FLOODWAY SCHEMATIC Figure 2

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-depths derived from the detailed hydraulic analyses are shown within this zone.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 100-year floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and to areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

7.0 OTHER STUDIES

A Flood Insurance Study has been prepared for the unincorporated areas of Montgomery County (Reference 1). The results of this study are in exact agreement with the results of that study.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, Liberty Square Building (Second Floor), 105 South Seventh Street, Philadelphia, Pennsylvania 19106.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Federal Emergency Management Agency, Flood Insurance Study, Unincorporated Areas of Montgomery County, Maryland, Washington, D. C., August 1, 1984.

2. U. S. Department of the Interior, Geological Survey, Water Resources Research Council, Generalized Skew Coefficients of Annual Floods in the United States and their Application, Vol. 10, No. 4, by Clayton H. Hardison, Reston, Virginia, August 1974.

3. Ven Te Chow, ed., Handbook of Applied Hydrology, New York, McGraw-Hill, 1964.

4. Brian M. Reich, "Effects of Agnes Floods on Annual Series in Pennsylvania," Research Publication No. 74, Institute of Research on Land and Water Resources, Penn State University, June 1973.

5. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, October 1973.

6. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Users Manual, Davis, California, October 1973.

7. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Training Document No. 1, Davis, California, 1969.

8. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Bridge Routines, Training Document No. 6, Davis, California, June 1974.

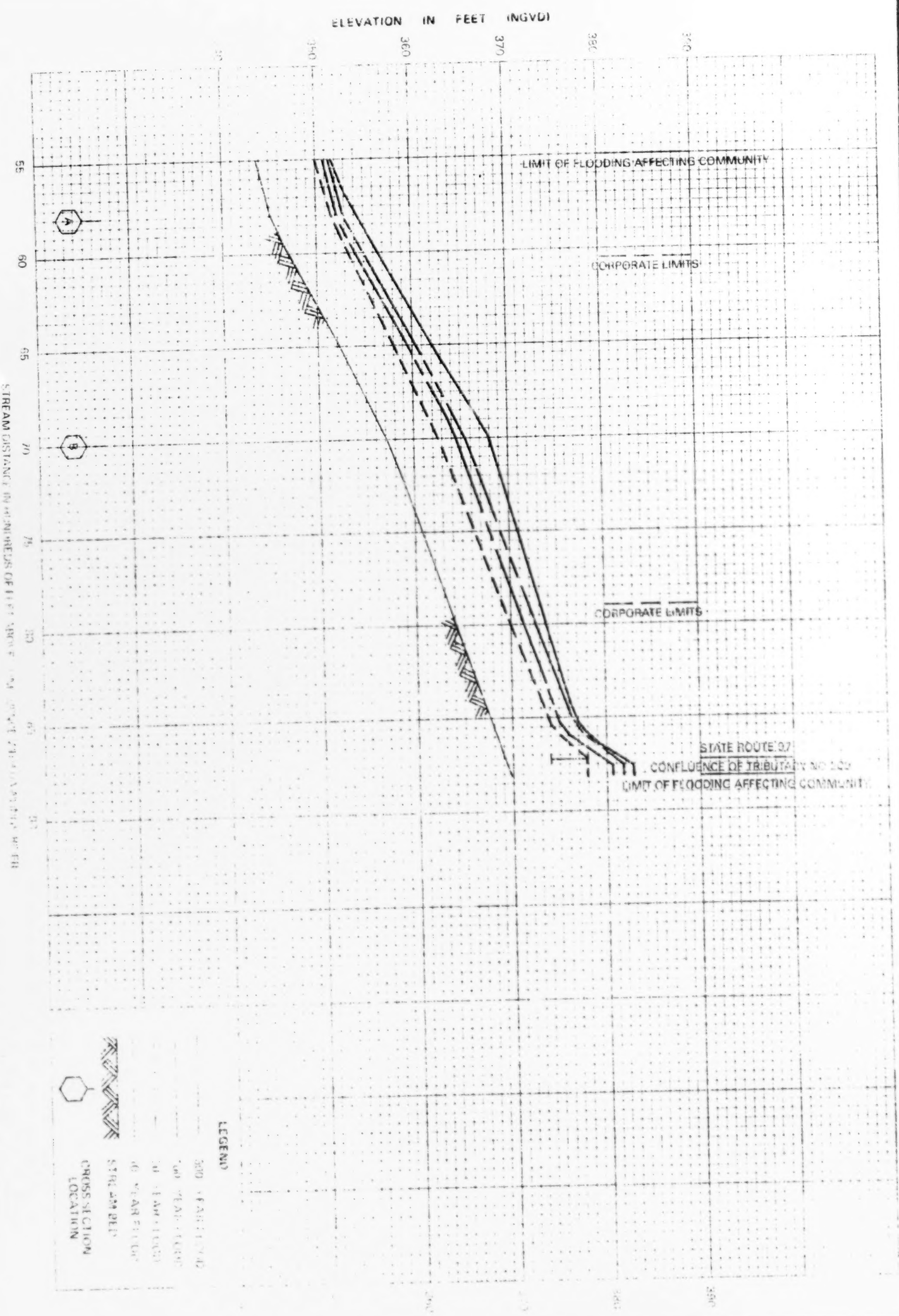
9. Dalton, Dalton, Little, and Newport, An Iterative Method for Determination of Starting Water Surface Elevation, by C. K. Sarkar, Bethesda, Maryland, March 1976, (unpublished).

10. Maryland National Capital Park and Planning Commission, Map, Scale 1:24,000, Contour Interval 10 Feet.

EXHIBIT 3 - ELEVATION REFERENCE MARKS

Reference Mark	Elevation (Feet NGVD)	Description of Location
RM 1	380.70	Standard WSSC brass bolt and washer in top of east headwall over Reddy Branch on State Route 97 located 300 feet northwest along State Route 97 from intersection with Brookeville Road.

135365



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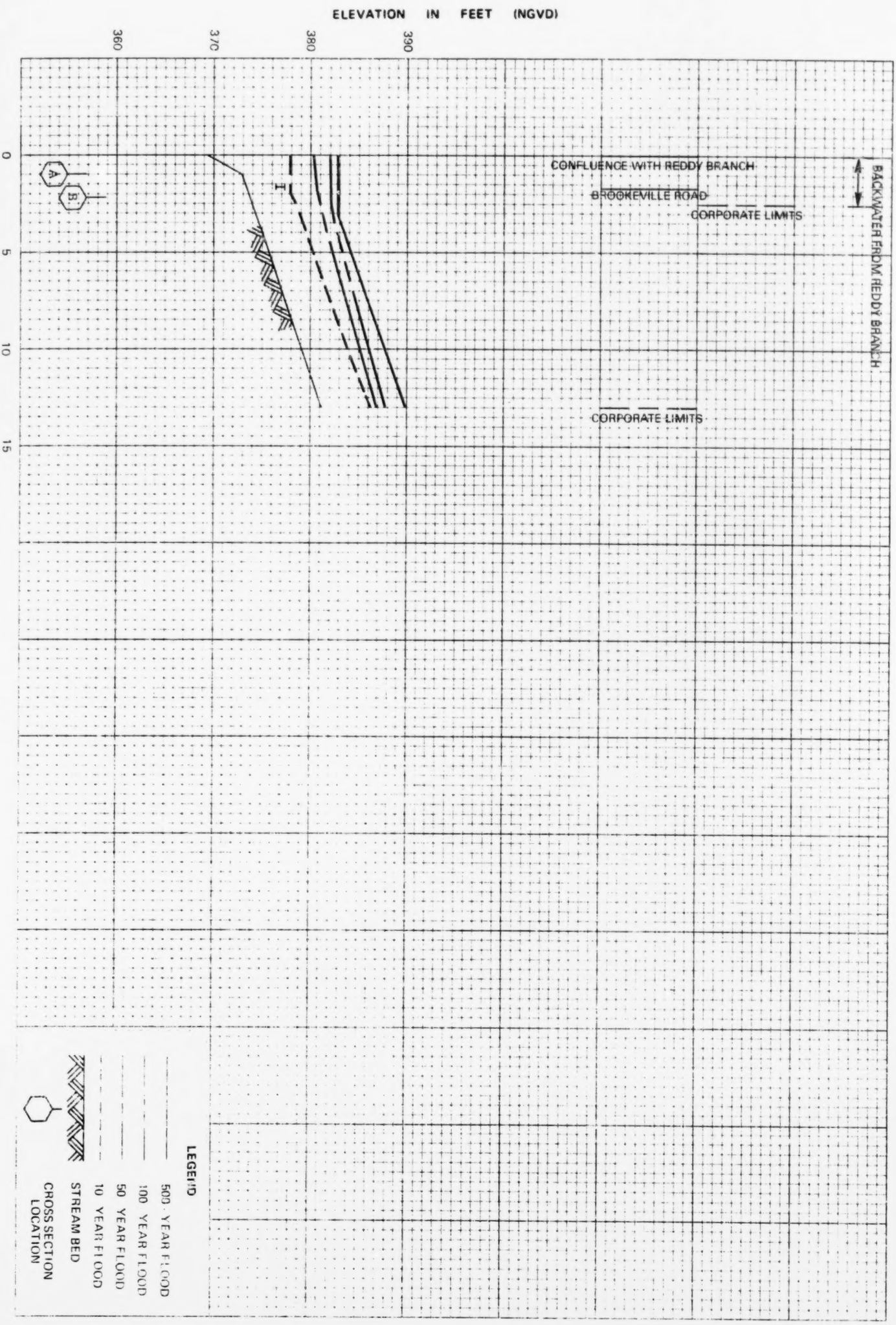
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF BROOKEVILLE, MD

MONTGOMERY CO.

FLOOD PROFILES

REDDY BRANCH



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FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF BROOKEVILLE, MD

(MONTGOMERY CO.)

FLOOD PROFILES

TRIBUTARY NO. 209